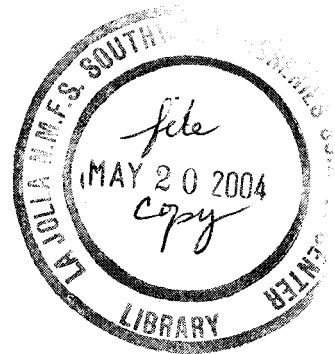


NOAA Technical Memorandum NMFS



APRIL 1984

THE HAWAIIAN MONK SEAL ON LAYSAN ISLAND: 1982

Doris J. Alcorn

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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Center

NOAA Technical Memorandum NMFS

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THE HAWAIIAN MONK SEAL ON LAYSAN ISLAND: 1982

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ABSTRACT

A 3-1/2 month observational study of the endangered Hawaiian monk seal, Monachus schauinslandi, was conducted on Laysan Island from 15 March to 30 June, and an additional census was conducted on 10 July 1982. Monk seals were identified by natural markings and scars, and an identification file including sketches and photographs was established. A census was conducted approximately every 2 days. Reproduction, injuries, and mortalities were monitored, and scats, spews, and net flotsam were collected.

Total beach counts, excluding pups, ranged from 66 to 119 and averaged 90 seals. Thirty pups were born, and the average lactation period (for 16 mothers) was 39.4 days.

Five seals died, two of which were nursing pups. At least nine injuries occurred, two of which were serious. Three nonfatal entanglements in debris were seen, and 26 net and rope fragments capable of entangling seals were found and sampled.

Collections were made of 40 parasitic scat samples, 210 scats, 7 spews, and specimens from 3 necropsies.

Three observations not previously reported for Hawaiian monk seals were: 1) sharks killed and consumed a monk seal, 2) a pup suckled on its natural mother and a foster mother long enough to comprise a total nursing period twice the normal period, and 3) interatoll movement of an adult female was recorded wherein she pupped on Laysan and moved to Lisianski Island to molt.

INTRODUCTION

Laysan Island (lat. 25°42'N, long. 171°44'W) is a coral-sand island about 2.8 km long and 1.7 km wide, located 1,350 km from Oahu in the Northwestern Hawaiian Islands (Fig. 1). It lies within the Hawaiian Islands National Wildlife Refuge. Laysan Island is one of eight major haul-out sites for the endangered Hawaiian monk seal, Monachus schauinslandi. Intensive monk seal studies have been conducted yearly on Laysan since 1977 during 3- to 7-month field camps (Johnson and Johnson 1978, 1981a, 1981b; Knudtson¹). Studies prior to 1977 consisted mainly of periodic censuses.

During 1982, a two-person field camp was established on Laysan by the Southwest Fisheries Center (SWFC) Honolulu Laboratory, National Marine Fisheries Service (NMFS) (Appendix A). The Hawaiian monk seal was the primary research responsibility of one person, and the green sea turtle, Chelonia mydas, the responsibility of the other. The purpose of the monk seal study was to continue observations similar to those initiated in 1977, specifically to: (1) conduct censuses, (2) monitor injuries and deaths and their causes, (3) monitor reproduction, and (4) collect scats, spews, and net samples.

This report describes the findings of this 1982 Laysan study of the Hawaiian monk seal. Observations were made during a 3-1/2 month field camp from 15 March to 30 June. Data from a census on 10 July are also included.

MATERIALS AND METHODS

The 1982 monk seal study was entirely observational; monk seals were handled only during isolated rescue incidents, and no marking was attempted. Throughout the field study, we tried to avoid disturbing the monk seals since human disturbance reportedly can cause them to abandon haul-out areas (Kenyon 1972).

The locations of monk seals were recorded on maps. For ease of data analysis, the island was subsequently divided into 20 numbered sectors (Fig. 2). These sectors are roughly equal in size and thus differ from the sectors used in 1977 (Johnson and Johnson 1978).

Identification of Individuals

An identification (ID) file was established for monk seals that had recognizable characteristics, such as scars, natural markings, or flipper tags. Identification of adult females was emphasized, especially parturient females, so that their reproductive activity could be monitored in future years. Males and other age groups were added as time permitted. Data

¹Knudtson, E. P. 1981. Hawaiian monk seal observations at Laysan Island, March-July 1981. Unpubl. manuscript, 23 p. Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, P. O. Box 3830, Honolulu, HI 96812.

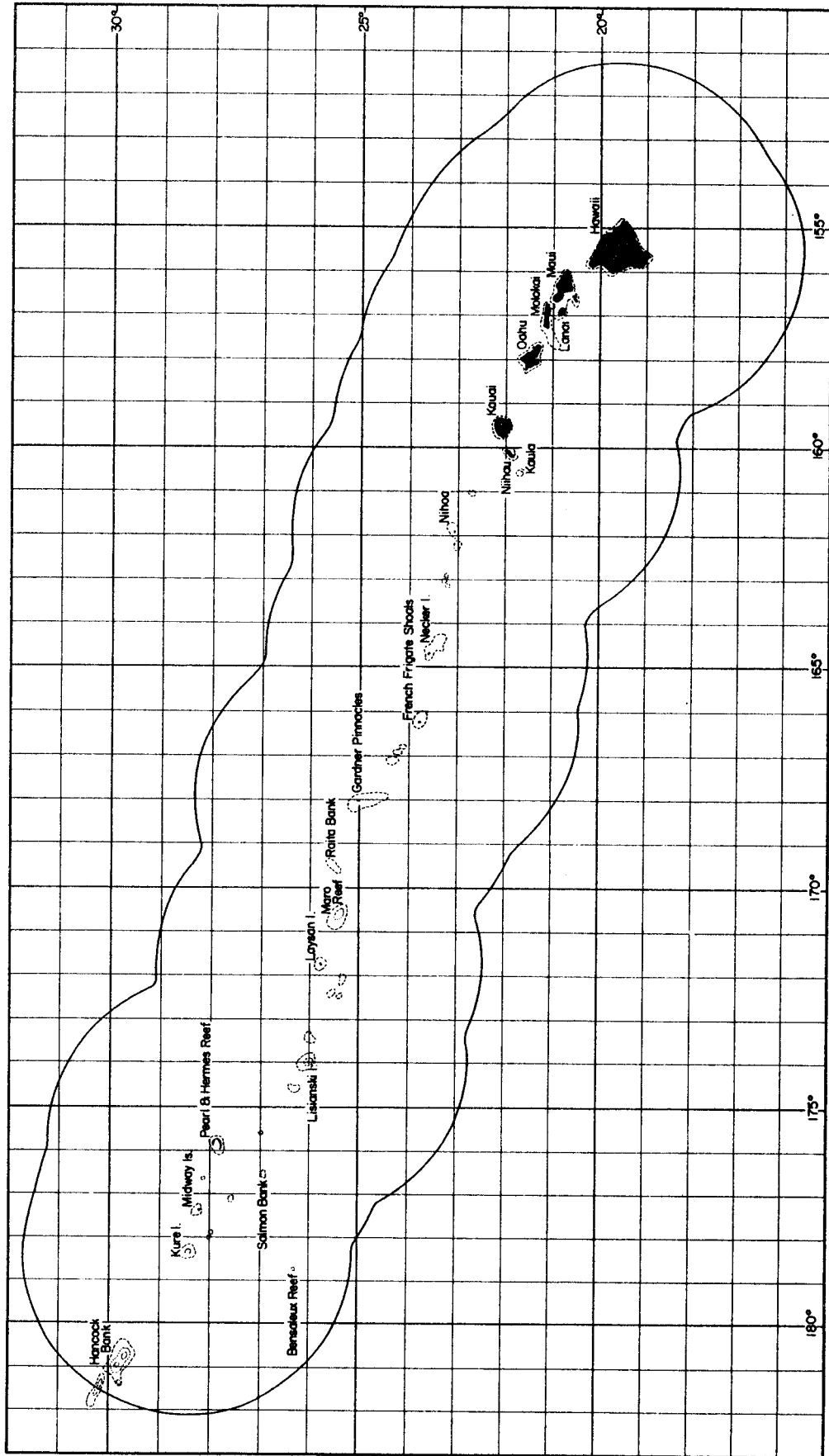


Figure 1.--Location of Laysan Island, Northwestern Hawaiian Islands.

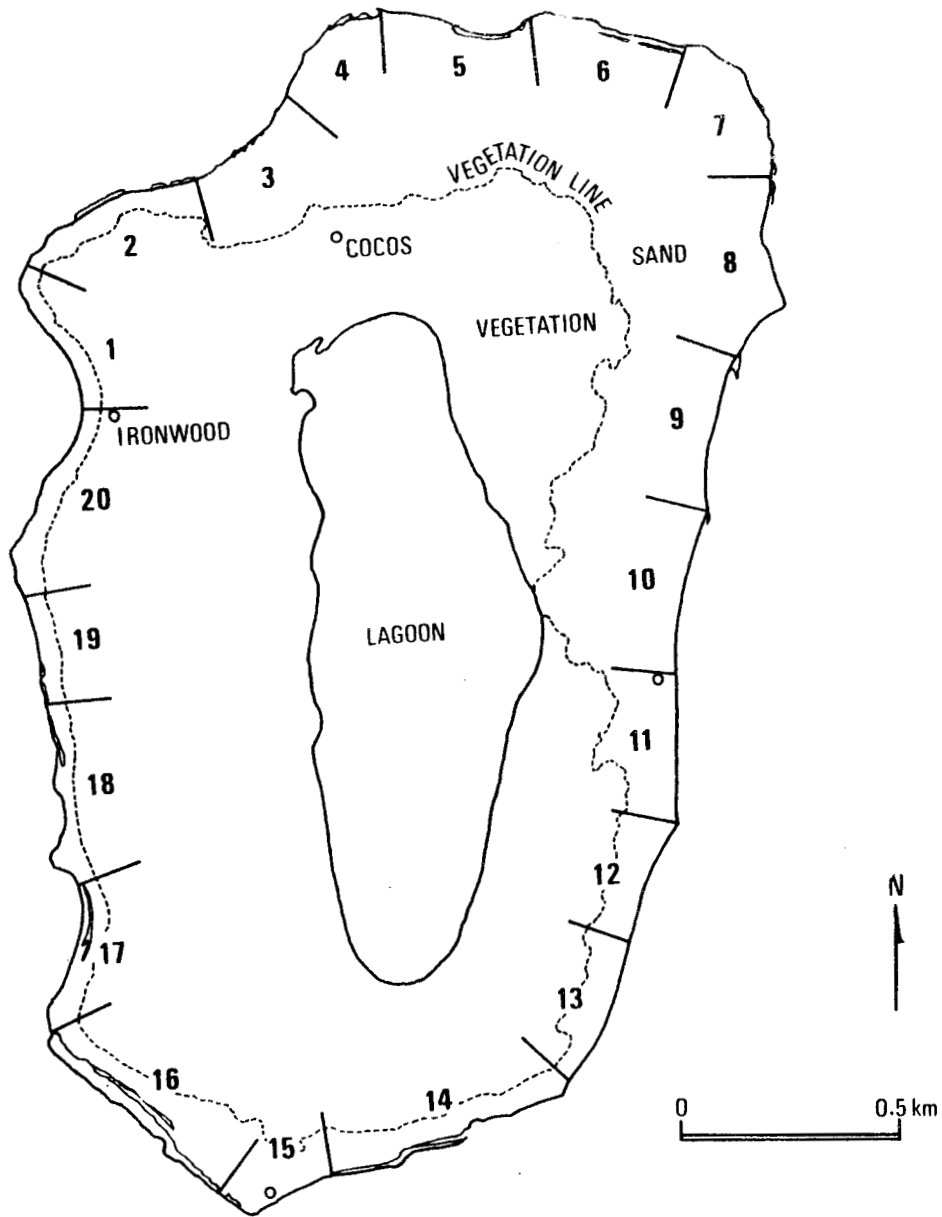


Figure 2.--Map of Laysan Island showing 20 sectors, 1982.

recorded include identification marks, age class, sex, location on island, and date. Identifiable characteristics were recorded with sketches and black and white photographs. A 35-mm single lens reflex camera was used with a 75-205 mm macrofocusing zoom lens and Kodak² Plus-X film (ASA 125).

Censusing

Beach counts of monk seals were usually made every 2 days. Two-person timed censuses were alternated with one-person untimed censuses. The timed censuses provided precise, repetitive methods for censusing, and the untimed ones provided for additional monitoring of the population. The two-person counts usually took 3 h and were conducted between 1100 and 1500 (Hawaii Standard Time). Each observer took half of the island starting from camp on the west side and ending at the sector 8/9 boundary, and alternated the half of the island censused each time. One-person counts took from 4 to 10 h and usually started in the morning, but starting time and direction varied; emphasis was on recording identification marks and taking identification photographs in addition to monitoring injuries and mortalities and recording census data.

The following criteria were used to count seals: 1) weaned pups and mothers with nursing pups were counted regardless of where they were, on land or in the water, 2) all other seals were counted if they were more than 50% out of the water, 3) identifiable seals were counted only once per census, even if seen again, 4) monk seals on offshore reefs (35 m or more offshore) were noted but not counted in the total. These criteria were based on suggestions by Knudtson (footnote 1) to provide techniques which are as precise and repeatable as possible.

Census data recorded for each individual included the following: age class, sex, molt condition, location on island, distance from water and vegetation, and haul-out substratum. Sex was recorded only if the genital area was seen or if the seal was a known individual. Notations on weather and sea conditions were made. Identification marks were recorded, including numbers from artificial bleach marks and hind flipper tags applied during previous studies.

Reproduction

Birth date, location of the mother/pup pair, sex of pup, and size and condition of mother were recorded during censuses or when first observed. Weaning date, location, and degree of molt at weaning were recorded. The main pupping areas on the northwest and west side of Laysan were usually visited daily. Recognizable characteristics of mothers and pups were recorded as soon as possible so that their movements and pup exchanging could be monitored.

²Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

Monitoring Survival

Injuries, deaths, and factors causing them were constantly monitored. Type and extent of injury, location on body, possible cause, and age, sex, and location of these seals were recorded. Progress of injured or ailing seals was monitored, and photographs were taken when it was possible to do so without disturbing the seal.

Observations for inter- and intraspecific behavior potentially affecting survival were made, with emphasis on detection of aggressive behavior of adult male seals and shark interactions with seals. To assess the possible problem of injury to weaned pups by aggressive adult males, weaned pups at several locations were observed for varying periods of 1-1/2 to 12-1/2 h. During these observations, the number of patrolling adult males and number and type of weaned pup interactions with these males were recorded.

Collection of Materials

Necropsy

Photographs were taken and external measurements recorded for each dead seal recovered. Endoparasites, stomach contents, and small samples of major organs were preserved in 10% Formalin solution, with initial volume of fixative to specimen at least 10:1. Skulls were flensed and staked to dry.

Net and Other Fishing Gear

An inventory was conducted along the island perimeter to determine type, location, and amount of net, line, or rope debris that could entrap seals. Data recorded included the following: 1) location on island, 2) size (outside dimensions of net when possible), 3) description, including type of material, mesh size or rope diameter, and 4) estimated weight, when possible. Inventoried items were marked with surveyors' tape to prevent double counting and to determine arrival frequency of new nets. Samples were taken so that accurate weights and origin of the materials could be determined.

Scats and Spews

Scats were collected and placed in Whirlpack bags. If very fresh, the scat was immediately examined and obvious parasites or a small scat sample for parasitic oocyte analysis was placed in a small vial of 10% Formalin. The date, location on island, freshness (wet or dry) of the scat, and the age class and sex of the seal, if known, were recorded. To collect more samples from age and sex groups, markers were placed near resting seals of determinable sex and/or age for later inspection and scat collection. Scats were dried, when weather permitted, and placed in drums for screening and identification of prey items at a later date.

Spews were collected, and data similar to that for scats were recorded. A preliminary examination of contents was made, parasites were placed in 10% Formalin, and the spews were dried for processing at a later date.

RESULTS AND DISCUSSION

Identification of Individuals

Natural Markings

Identification cards were compiled in the field for 40 females and 6 males. More cards were later compiled from field notes and photographs. Over 350 identification photographs were taken. These are filed at the Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, P. O. Box 3830, Honolulu, HI 96812.

Bleach and Tag Numbers

Four seals were seen with identification numbers from earlier studies. Three of these seals were juveniles with bleach marks "A," "101," and "WI." One was an adult female with a metal hind flipper tag "A5;" she is discussed below under "interatoll movement." A yellow plastic tag, "A625," was found in the vegetation and records indicate it was attached to a male on Laysan in 1969 as a 2-year-old.

Interatoll Movement

Two incidents of interatoll movement were recorded, both involving adult females:

1. An adult female with a metal tag, "A5," on the right hind flipper was initially seen on 26 March. She was resighted periodically during the Laysan field season, and was last seen there on 16 June 1982. At that time she was large, possibly preparturient, and had not molted.

She was tagged as a yearling on East Island, French Frigate Shoals, 12 March 1967. It is not known when she moved to Laysan.

2. An adult female seen on Laysan in the spring appeared at Lisianski Island in midsummer, after the Laysan field camp personnel had moved there. Identification was based on scars and natural markings (Fig. 3), and was verified with sketches and photographs.

She was first seen on Laysan on 14 May, pupped there 15 or 16 May, weaned her pup 21 or 22 June, and was not resighted before the field camp departed on 31 June 1982. She appeared on Lisianski Island, a distance of about 185 km from Laysan, on 22 July. Her arrival date at Lisianski is known with certainty because all seals there were bleach marked with identifying numbers.

On Lisianski this female was frequently observed with different adult males hauled out with her. Molt was first noticed on 5 August, at which time most of the ventral surface had molted, and was almost complete by 11 August 1982. She was still present on

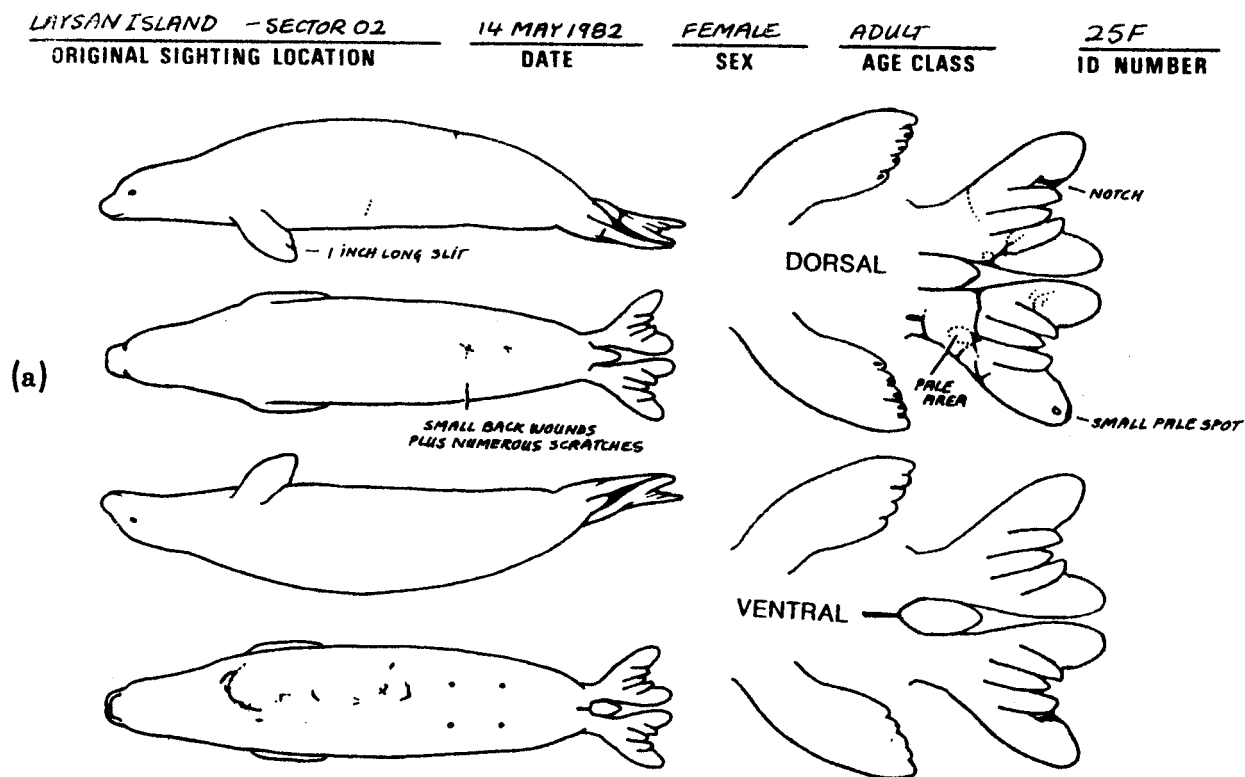
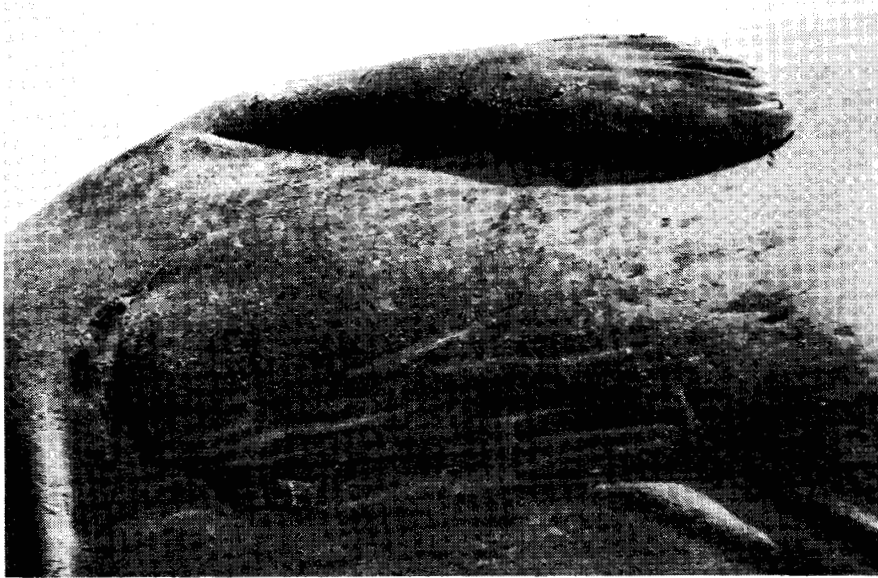
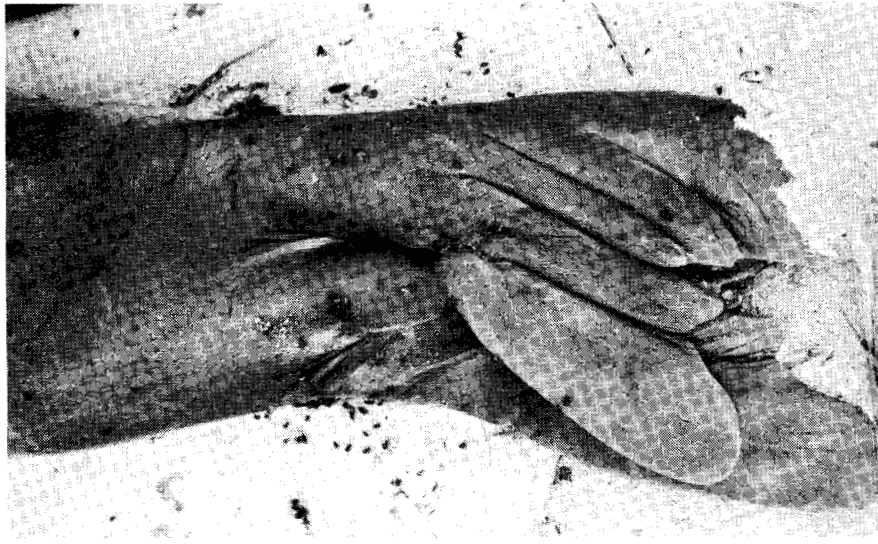


Figure 3.--Natural markings used to identify the seal which pupped on Laysan and molted on Lisianski, 1982. (a) Identification drawing. (b) Ventral scars. (c) Right hind flipper scars. (d) Left hind flipper scars.

(b)



(c)



(d)



Figure 3.--Continued.

Lisianski in September when the field camp departed. She was seen there during November (Henderson³) when a camp was reestablished.

Interatoll movements of bleach marked or tagged monk seals have been previously reported (Schreiber and Kridler 1969; Johnson and Johnson 1978; Johnson et al. 1981; Johnson and Kridler 1983). However, the adult female which moved from Laysan to Lisianski represents the first record of inter-atoll movement where a female pupped at one atoll and moved to another to molt during the same season.

Censusing

Counts, 1982

Overview.--Forty-eight censuses were conducted on Laysan from 17 March to 10 July 1982 (Appendix B). Twenty-six of these were untimed, entire island counts conducted by one person, and 22 were timed, two-person counts averaging about 3 h.

Total counts, excluding suckling and weaned pups, ranged from 66 to 119 seals (average of 90). Total counts, including pups, ranged from 81 to 130 seals (average of 106).

Timed counts versus untimed.--The counts on timed, two-person censuses averaged 91.5 seals, slightly higher than the 88.8 average of the untimed, one-person censuses. This is probably due to the length of time required for one person to census the entire island, resulting in some areas being counted early in the day when many seals had not yet hauled out. Double counting of seals was probably not a more significant factor in the one-person census although censuses took longer, because this person was more familiar with individual seals and, therefore, more likely to avoid double counting.

To ensure that both observers were aging and sexing seals similarly, a comparison census was conducted on 18 June. Both observers walked together and individually recorded the age classes and sexes of 71 seals. Although the sample size was small, it covered the range of age and sex groups. Results indicated that there were no differences in sexing; the two observers agreed on the sex of all seals. Observers disagreed on the age class of three seals (4% of the total), which is minor considering that age classification based on body size is subjective.

Counts Compared with Previous Years

Figure 4 shows a comparison of the 1982 two-person timed counts with those from three previous spring periods. Only two-person counts are

³J. R. Henderson. Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, P. O. Box 3830, Honolulu, HI 96812, pers. commun., December 1982.

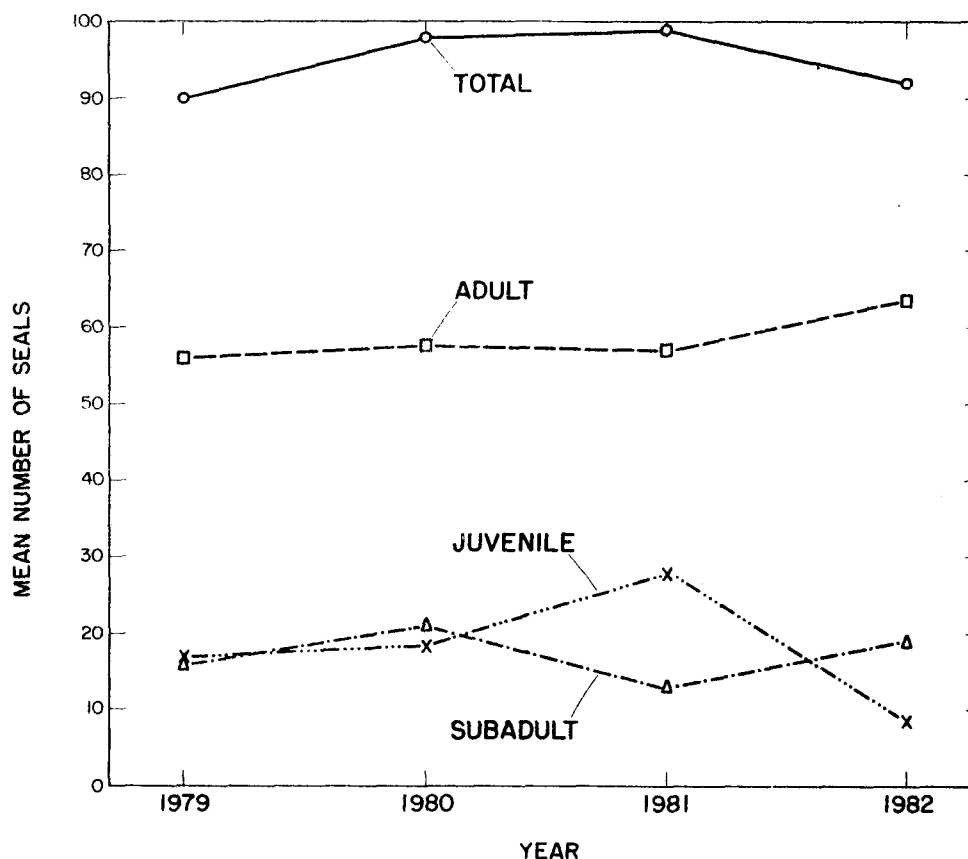


Figure 4.--Mean number of seals, excluding pups, on Laysan Island, spring 1979-82. Data from 1979 to 1980 based on B. Johnson and P. Johnson (pers. commun.) and 1981 from Knudtson (text footnote 1).

included as these were utilized in past studies. Data used for this comparison were taken from the same time period available from each year's study (28 March to 17 June). Sex groups were not compared because the sexes of many seals were undetermined in the 1982 counts.

The beach counts appeared relatively stable over the past 4 years during spring. There was a nonsignificant mean decrease of seven seals between 1981 and 1982. This decrease may reflect normal variation, indicate a downward trend, or most likely reflects a difference in methodology of observers. For example, in 1982 monk seals swimming or hauled out on offshore reefs were not included in the total, but they were included in previous studies.

The greatest difference between 1981 and 1982 was the sharp decline in mean number of juveniles, shown by a chi-square test to be significant. This may be an artifact caused by different observers since visually aging monk seals is subjective. However, counts of juveniles increased between 1980 and 1981 when researchers did not change. The number of juveniles

should be closely monitored in future studies, in the event this is not an artifact but reflects high juvenile mortality.

Island Use

The following distributional pattern of seals was observed between March and June 1982. Seals hauled out on all areas of the island with the exception of the south coral shelf in sector 16 (Fig. 2). A few adult males did use the southern tip of the coral shelf which extended into sector 15, when it was covered with sand in late spring. The remainder of sector 15 was used almost exclusively by adult and subadult males plus a few juveniles of both sexes; a few adult and subadult females were seen there in June. Highest seal density was frequently in the northeast corner (sectors 6-8), especially in June. Density was usually lowest along the east side shallows (sectors 9-14). This is consistent with the findings of Johnson and Johnson (1978).

Seals hauled out from the edge of the water to 77 m inland. They sometimes hauled out at low tide on the offshore reefs on the west side and the nearshore exposed limestone rocks and reef on the southeast corner and east side.

Molt

The first seal in molt on Laysan was a subadult female, seen on 3 April (sector 11). The first seals to molt in other age and sex groups were as follows: adult female on 8 April (sector 5), subadult male on 7 May (sector 7), juvenile male on 3 June (sector 5), and juvenile female on 29 June (sector 8). No adult males had begun to molt prior to the last census of the season on 10 July.

Although not quantified, the majority of seals molting between April and late June hauled out in the northeast corner of the island (sectors 5-8).

Reproduction

Pup Production and Survival

Production and survival, 1982.---Pup production was 30 pups (20 females, 9 males, 1 unknown). It is possible that a few more were born after the last census on 10 July, since the pupping period has been reported to extend from January to August (Johnson and Johnson 1981a). One weaned and 6 nursing pups were present during the first island census on 17 March, 22 were born during my stay on Laysan, and 1 new pup was seen during the 10 July census (Appendix C).

Two male pups died; one suckling pup disappeared during a storm and the other apparently died during birth. Details are given in the section on deaths. Known mortality for preweaned pups was therefore 7%. More pups could have died before observations began. Some weaned pups may also have died since most weaned pups were not identifiable, and after 12 April the number of weaned pups counted on a census was always less than the total number known to have been weaned.

Table 1.--Pup production and survival to weaning, Laysan Island, 1977-82 (-- indicates data not available).

Year	Total No. of pups	No. of females	No. of males	No. of unknown	No. of deaths	Percentage mortality
1977 ¹	42	23	17	2	4	10
1978 ²	29	17	12	0	1	3
1979 ³	32	--	--	--	4	13
1980 ³	33	--	--	--	6	18
1981 ⁴	27	--	--	--	1	4
1982	30	20	9	1	2	7

¹B. Johnson and P. Johnson 1978.

²B. Johnson and P. Johnson 1981a.

³B. Johnson and P. Johnson, pers. commun.

⁴Knudtson, text footnote 1.

Comparison with past years.--Observed production of 30 pups during the 1982 season is similar to the 29-33 pups reported for 1978-80 (Table 1).

Pup production data for Laysan are also available for 1977 and 1981, but are not comparable due to the much larger population before the 1978 Laysan seal die-off (Gilmartin et al. 1980; Johnson and Johnson 1981a), and the shorter study duration (2-1/2 months) of the 1981 study (footnote 1).

The 1982 sex ratio of pups was skewed towards females; 20 (69%) of the 29 pups of known sex were female. This is a higher percentage than the 40 (58%) female pups of 69 total pups of known sex born during the 1977-78 pupping seasons (Johnson and Johnson 1978, 1981a).

Observations of births.--The final moments of one birth were observed, and another mother and pup were observed immediately after birth. In the first incident, the final few minutes of birth were seen near midnight at full moon (Kam⁴). The birth occurred inside the vegetation line, about 38 m from the sea. Presentation was cephalic, as reported for an earlier monk seal birth at Kure (Ruehle and Johnson⁵). The pup worked its way to the mother's head and they sniffed each other. The afterbirth was expelled approximately 30 min following birth. Another birth at Laysan in 1977, however, was caudal (Johnson and Johnson 1978).

⁴A. K. H. Kam, Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, P. O. Box 3830, Honolulu, HI 96812, pers. commun., May 1982).

⁵Ruehle, J., and A. M. Johnson. 1977. Observations of monk seals and other wildlife, Kure Atoll, 10 February-13 May 1977. Unpubl. manuscript, 14 p. + 11 tables, 6 figs., and Appendix A. Dep. Int., Fish Wildl. Serv., Natl. Fish Wildl. Lab., Anchorage Field Stn., Anchorage, AK 99503.

In the second incident, delivery was complete but the pup's posterior was still enveloped in the sac. The birth occurred about 1 m from the sea, on coral rubble and sand. The mother made a "moaning" vocalization and frequently looked back at the pup. As in the first incident, the pup wiggled up to the mother's head and much sniffing occurred. The afterbirth was expelled approximately 43 min following birth. The pup did not suckle for at least the first 3-1/2 h following birth at which time observations were ended. During this time, the pup probed at the mother's abdomen but was not able to locate a nipple. Johnson and Johnson (1978) also did not see suckling during 1-1/2 h of observations following a Laysan birth; however, Ruehle and Johnson (footnote 5) observed suckling at Kure within 40 min of birth.

Time and location of births.—Most of the seals pupped between March and May. There was a slight peak in pupping from the end of March to early April (Fig. 5). This is generally similar to available data from Laysan in 1977 and 1978 (Johnson and Johnson 1978, 1981a). As in 1977 (Johnson and Johnson 1978) and 1981 (footnote 1) most pupping occurred along the northwest/west beaches of the island.

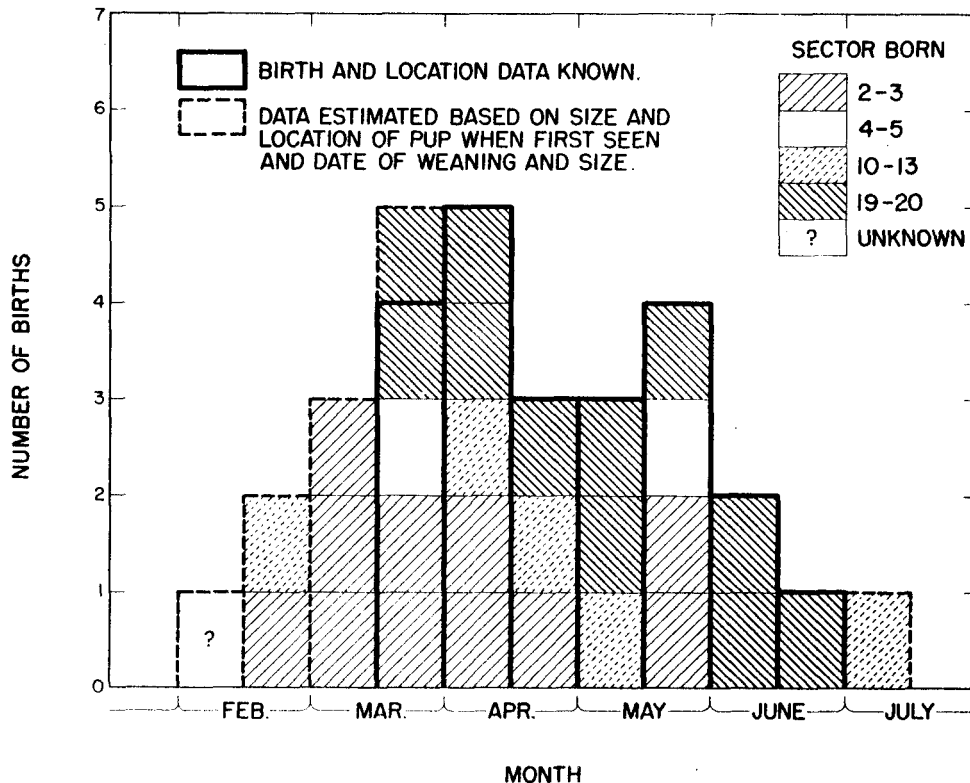


Figure 5.--Number and location of pups born per 2-week period, Laysan Island, 1982.

In 1982, 73% of the pupping occurred along less than 1.3 km (about 11%) of the island perimeter, and was clustered in the northwest corner and midwest side of Laysan (Fig. 6). Comparable pupping data in specific areas

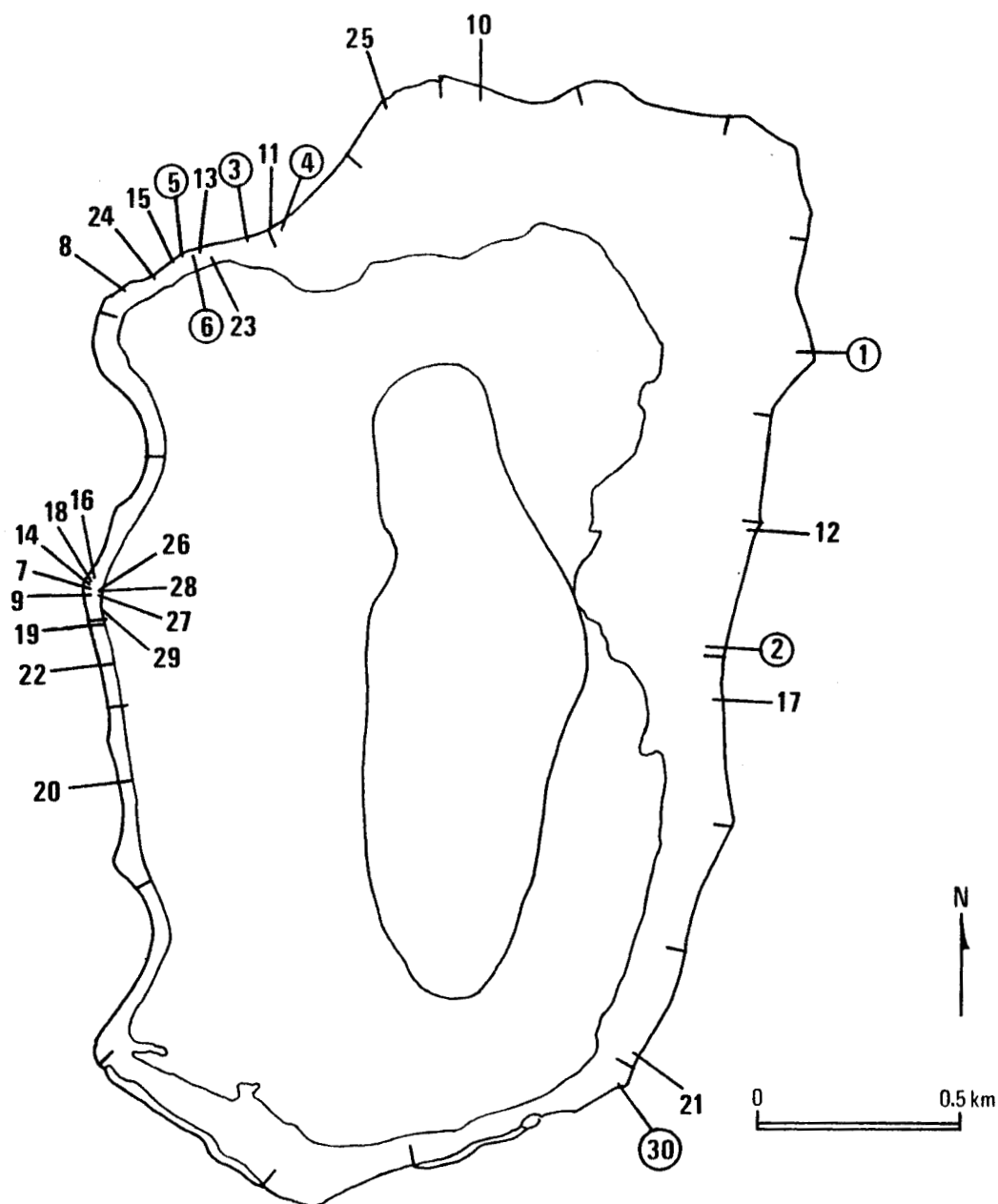


Figure 6.--Map of pupping sites, Laysan Island, 1982. Numbers indicate probable order of birth for each pup. Circled numbers indicate pup was born before or after the study and location given is where pup was first seen.

of Laysan are available only for 1977 (Johnson and Johnson 1978) before the seal die-off of 1978. Compared with those data, the percentage of pups born in specific areas differs in 1982. Of the 30 pups born in 1982, 40% (57% of the 42 pups in 1977) were born on north-northwest beaches, sectors 1-5, 40% (36% in 1977) in the central west side, sectors 18-20, and 20% (7% in 1977) in the east side. Pupping apparently has almost tripled on the east side of the island, but sample size is small and data are needed from additional years to determine if this is a normal variation or a trend. Reproductive histories of individuals are not available, so pupping site specificity of the parturient females cannot be determined. It should be noted that the sectors in the 1977 study differed from those used in 1982.

Pup Exchanges

Two incidents of the temporary transfer of pups to mothers other than their own were seen, both in the northwest area of Laysan (sectors 2 and 3).

In the first incident, a mother ended up with both pups, and the other mother was not seen in the vicinity. The mother with both pups suckled the pup that was not hers while she kept her natural pup at a distance with mouth threats. Both pups were large and older than 30 days. The pups were back with their natural mothers when seen the next evening.

In the second incident, two pups were exchanged. The pups were of greatly disparate sizes (40+ and 20 days old), and both mothers and pups were crowded together in a small pool. During 15 min of observations, the mothers exchanged pups at least four times, while they lunged at each other, made mouth threats, and vocalized. The smaller pup initiated one of the exchanges when it swam away from its mother and over to the other mother and pup pair 2 m away.

In 1982, at least 60% of the mothers weaned their own pups, i.e., did not permanently exchange pups, so a maximum of only 40% of the pups could have been permanently exchanged. This is known because of temporal or spatial isolation, or because pups were identifiable. In 1977 on Laysan some pups were exchanged (Johnson and Johnson 1978), and in 1978 at least 45% of the mothers weaned a pup not her own (Johnson and Johnson 1981a). So although more pups were born in 1982 (30) than in 1978 (29), more permanent exchanges were made in 1978.

Lactation Period

Lactation period ranged from ± 33 to 55+ days (Appendix C). Seals on Laysan had been reported to suckle for a total period of 27-50 days (Johnson and Johnson 1978, 1981a). The pup which suckled a verified 55 days constituted an unusual event in that it was nursed an estimated minimum of 33 days (20 verified) before it was weaned, then suckled an additional 34-35 days on a foster mother whose natural pup had died (Alcorn and Henderson in press). Excluding that pup, the lactation period ranged from 33 ± 1 day to 48.5 ± 0.5 day (average of 39.4) for the 16 pups observed from birth through weaning.

The average duration of nursing is close to the 1982 average of 37.6 days ($N = 14$) on nearby Lisianski Island (T. Johanos⁶). However, it is longer than the 35 and 36 days reported for Laysan in 1977 and 1978 (Johnson and Johnson 1978, 1981a). This may be an artifact, since Johnson and Johnson did not report how durations were determined. Also, their sample size was larger since the longer 6-month field camps allowed more pups to be followed from birth through weaning.

Shoreline Movements and Weaning

The actual weaning process was not observed. Sites where 22 pups were first seen following weaning are shown in Figure 7. Based on this and on observations made throughout the study, the following conclusions can be drawn concerning the movements of mother-pup pairs between birth and weaning.

There were three general pupping areas, and mother-pup pairs did not move from one area to another. The home ranges of nursing pups born on the central west side (sectors 18-20), those born on the north-northwest side (sectors 2-5), and those born along the east side (sectors 9-14) did not overlap.

Lack of movement by mother-pup pairs between the east side and other areas of the island can be explained by island topography and distance. Laysan is a large island with a perimeter of about 11.2 km, so east side mother-pup pairs were separated from north and west pupping areas by more than a mile of rough water. The southern end of the island lacks an exposed offshore reef, and high surf crashes directly against the high coral shelf and beach (sectors 15 and 16). The northeastern corner of Laysan is also buffeted by rough waters because only a small amount of reef is exposed, and this is the windward corner exposed to heavy trade winds. Although surf conditions vary with weather, these two areas are considerably rougher than the shallow protected area between them, more readily accessible to large sharks, and thus these areas probably act as barriers to mother-pup pair movement.

The shoreline distances mother-pup pairs travel is highly variable. Pup No. 10 never appeared to travel from the vicinity of the birth site, and was weaned there. Pup No. 21 was apparently weaned an estimated 950 m from its birth site; this is an estimate, since it was not located for 2 days after weaning, and interactions with other seals or other factors can influence movement of pups following weaning. Another pup moved a verified 500 m between birth and weaning, and at least two others moved 400 m, indicating that these distances are not uncommon.

⁶T. C. Johanos, Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, Honolulu, HI 96812, pers. commun., February 1983.

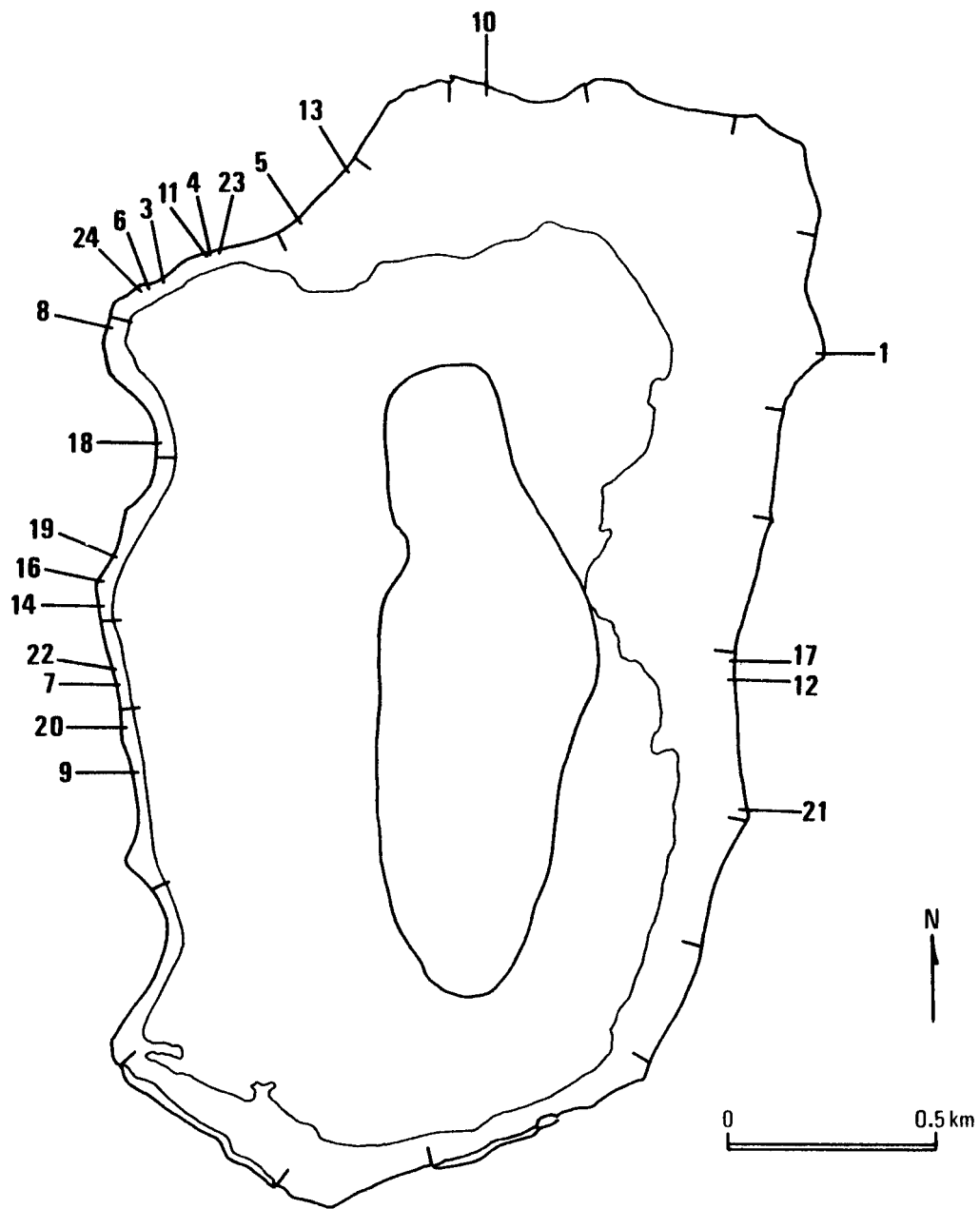


Figure 7.--Map of weaning sites, Laysan Island, 1982. Numbers indicate probable order of birth. Locations given indicate where pup was first seen following weaning.

In 1981 at Laysan, Knudtson (footnote 1) found that most mother-pup pairs ($N = 10$) remained within 100 m of the birth sites, and some moved greater distances just before weaning. In 1977 most mother-pup pairs remained close to the birth site until 1 to 5 days before weaning (Johnson and Johnson 1978). Thus pup age is a factor as to when the pair moves. Although not quantified, it appears that shoreline characteristics at the birth site might affect the distance moved. On the east side, the flat sandy beach and reef shallows lack distinctive landmarks, such as coves. Mother-pup pairs appeared to move more in this area than any other, and it was here that the greatest distances of movements were recorded.

Mother and Pup Identification

Twenty-six (87%) of the 30 parturient females had markings which might make future identification possible. Of the four not identifiable, two lacked marks, and two were not scrutinized for marks because they pupped before or after the March-June study period.

Of the 28 pups closely observed before weaning, 6 had natural markings. Two pups had a lateral diffuse natural bleach spot, and four (14%) of the pups had a bold white mark on a foreflipper and/or the ventral surface. Wirtz (1968) noted that 12.7% of the 56 pups at Kure Atoll in 1964-65 had white markings. Although the white markings on the foreflipper and the diffuse bleach marks remained obvious on the Laysan pups after weaning, the white ventral marks disappeared.

Mating Incident

A mass mating incident involving 1 female and approximately 27 males was observed from the vessel Feresá just south of the west shore anchorage on 13 May 1982 (Shallenberger⁷). The incident was similar to the only other report of this kind, which also occurred off Laysan in the same area, May 1978 (Johnson and Johnson 1981a). As in the 1978 incident, males repeatedly bit the back of the female creating open wounds, large tiger sharks circled under the seals, and the female was never seen on shore following the incident.

Deaths and Factors Affecting Survival

Deaths

Four seals died and one disappeared and presumably died (Table 2). The details of the deaths and disappearance are given below. Three necropsies were performed (Appendix D):

⁷E. Shallenberger, Manta Corporation, Kailua, HI 96734, pers. commun., May 1982.

Table 2.--Monk seal deaths, Laysan Island, 1982
(? = gender identification tentative or unknown).

Date	Sex and age group	Probable cause	Sector
3/23-26	Male, nursing pup	Disappeared during storm.	10
4/12	Male, nursing pup ¹	Birth complications.	2
5/14	Female, juvenile ¹	Abcesses, possibly male inflicted lesions.	1
5/28	Female(?), subadult	Sharks killed this seal; injuries on back were male inflicted.	20
6/21	Female, adult ¹	Unknown.	2

¹Necropsies performed.

1. A suckling pup disappeared during a storm. It was large, without a sign of ventral molt, and estimated to be about 4 weeks old. It appeared healthy when last seen, suckling 4.5 m from the edge of the water during a storm. This was the only suckling pup on the windward side at that time, and the area was taking the full force of the storm. High winds, estimated in excess of 88 km/h, caused sandstorms, moderate surges along the beach, and enormous surf breaking on the fringing reef. The area could not be visited again until 3 days later because of the severity of the storm. At that time the mother was hauled out alone, and remained there another 3-4 days. She was very thin and vocalized frequently. Despite repeated searches, no sign of the pup was found.
2. A dead newborn pup was found near its mother. The mother rested on or near it, frequently vocalizing, until the pup could be removed for a necropsy the next afternoon. After the pup was removed, the mother remained in the general vicinity where she adopted a weaned pup (Alcorn and Henderson, in press). The histopathology indicated the pup experienced respiratory difficulties during birth, possibly due to trauma (Stemmerman⁸).

⁸G. Stemmerman, Kuakini Medical Center, Honolulu, Hawaii, pers. commun., November 1982.

3. A juvenile female was seen hauled out with a left lateral swelling plus two small open dorsal wounds. She was alert, but 5 days later was found floating dead in the water. There was extensive edema dorsally to the foreflippers. The wound type and location are consistent with that inflicted by adult male seals, as will be discussed later under adult aggression. The pathology report indicated there was focal necrosis in the liver probably due to bacterial infection, and that other body areas were also infected (footnote 8). There was also heavy parasitic infestation of the stomach and intestines, with associated ulceration of the stomach.
4. A subadult (thought to be female based on behavior) with open dorsal wounds, was seen hauled out, and 3 days later was attacked and consumed by sharks (Alcorn and Kam⁹). The type and location of wounds were consistent with those inflicted by adult male seals. Two large tiger sharks, Galeocerdo cuvieri, were in the vicinity, as were 20 smaller sharks thought to be gray reef sharks, Carcharhinus amblyrhynchos. The subadult was alive when attacked, and the open wounds did not appear to be bleeding. It should be noted that sexing based on behavior is tentative, and that the genital area of this seal was never seen to confirm the sex.
5. A dead adult female was seen floating in the wave wash with an adult male in attendance. Pelage was slipping, but there were no obvious internal or external abnormalities. Due to the length of time she had been dead, an estimated 4-7 days, fixed tissues were not of use to a pathologist.

Injuries

Numerous injuries occurred, and with the exception of a few minor ones, are listed in Table 3. Photographs of five of the injuries are shown in Figure 8. Two of the injuries were very serious, possibly fatal; details are given below. With the exception of the two injuries, all other injured seals were either stable or healing well when last seen.

1. An adult (tentatively classed as a female based on behavior), with a massive open back wound, was first seen hauled out in sector 2 on 10 May (Fig. 8b). She remained in the general area for 10 days, being largely inactive except for a few excursions into the water. During that time she was attended by one or more males. The following 2 days, she was tentatively seen on an offshore reef, then disappeared for 2 days before reappearing in sector 8. This was the last time she was seen, as she was not resighted during the next 35 days before field camp departure. When last

⁹D. J. Alcorn and A. K. H. Kam. First observation of a fatal shark attack on a Hawaiian monk seal. Manuscr. in prep. Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, Honolulu, HI 96812.

Table 3.--Monk seal injuries, Laysan Island, 1982
(? = gender identification tentative or unknown).

Date	Sex and age group	Probable causes			Type of injury
		Male inflicted	Shark	Unknown	
3/26	Female, adult	x	--	--	Two small round wounds, 6 cm diameter, post-dorsal.
4/1	Male, adult	--	x	--	Deep, ventral laceration, 45 cm long (Fig. 8a).
5/10	Female (?), adult ¹	x	--	--	Deep, open dorsal wound 65.5 x 35 cm, exposed vertically (Fig. 8b).
5/13	Female, adult ¹	x	--	--	Dorsal wounds (seen from <u>Feresā</u>).
5/21	Male, adult	--	x	--	Missing right hind flipper (Fig. 8c).
5/28	Male (?), adult	--	--	x	Lacerations all posterior surfaces (Fig. 8d).
6/12	(?), juvenile	--	--	x	Open wound, 8 cm long, right dorsolateral.
6/12	Female (?), adult	x	--	--	Open wound, 15 x 25 cm, posterodorsal (Fig. 8e).
6/29	Male (?), adult	--	--	x	Laceration on left foreflipper.

¹Disappeared, possibly died.

seen she was not emaciated, was not bleeding, and appeared stable. However, because of the massive nature of her wound, and the leaching of fluids into the water, she might have fallen victim to sharks. Her injuries were probably inflicted by adult male seals (see Adult Aggression below).

2. A second possible fatality involved the adult female seen during the mass mating incident described earlier. Observers on the fishing vessel Feresā radioed the field camp on Laysan that the

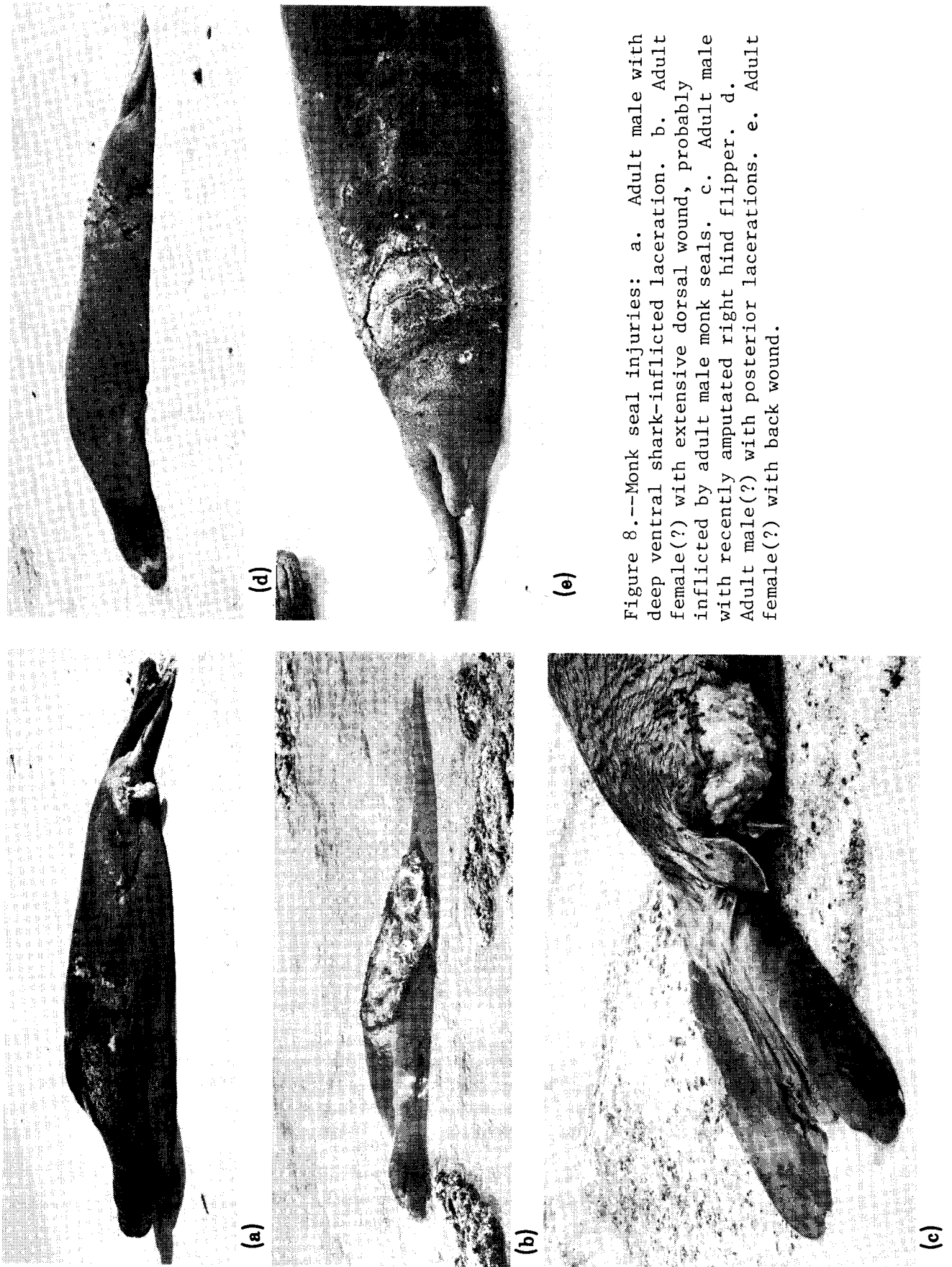


Figure 8.--Monk seal injuries: a. Adult male with deep ventral shark-inflicted laceration. b. Adult female(?) with extensive dorsal wound, probably inflicted by adult male monk seals. c. Adult male with recently amputated right hind flipper. d. Adult male(?) with posterior lacerations. e. Adult female(?) with back wound.

seal sustained numerous tearing back wounds and that large tiger sharks were circling underneath (footnote 5). Although the seal was roughly within 0.4 km of shore when the Feresa departed the scene, she was never seen on Laysan. During the only other mass mating sighting (Johnson and Johnson 1981a) large tiger sharks were nearby and that injured female was never seen again.

Adult Aggression

Adult males become extremely aggressive during the breeding season, and can inflict injuries during these encounters, as was seen during the mass mating. Adult males were seen attempting to mount weaned pups and

juveniles of both sexes, as well as immature and adult females. An adult male partly mounted and defended a dead decomposing adult female as the carcass was being removed from the water for necropsy. In another incident, a seal thought to be a male swam between a female and a tiger shark, temporarily driving the shark away; the shark was at least twice the length of the seal.

Male inflicted wounds may account for the long scars seen along the dorsal midline of many adult female seals at all major hauling atolls (Gilmartin¹⁰). At Laysan, at least one weaned pup in 1977 died from infection following an adult male bite (Johnson and Johnson 1978).

During 1982, two of the deaths (40%), and two of the serious injuries plus two minor ones (44% of the injuries) were probably caused by males. All six victims were probably females. Obvious male inflicted injuries on weaned pups were not seen in 1982.

Formal observations were made on seven dates of weaned pups and patrolling adult males for a total of 36.5 man-hours. Since one to six pups were observed simultaneously, observation time represents 76 pup-hours (man-hours times number of pups watched). Thirty-one percent of 71 patrolling seals interacted with one or more weaned pups. Over 50% of these interactions were on land. Sixty percent of the interactions involved some physical contact; pups of both sexes were involved in physical contact (female = 4, male = 7, and unknown = 6). Contact usually included sniffing, pushing with the muzzle against the pup, attempted mounting, or nipping. Mounting was observed only in the water. The most serious resulting injury seen was possible abrasion from nipping. Pups responded to the contacts by vocalizing, making mouth threats, or avoidance. Avoidance included swimming away or hauling out of the water, or if on land, moving up the beach or entering the water. Pup response was not always negative, and in one instance, a pup on its first postweaned day rapidly swam after an adult male as the adult departed; the pup vocalized loudly and gave up after 15 m when it was obviously outdistanced.

¹⁰W. G. Gilmartin, 1983. Recovery plan for the Hawaiian monk seal, Monachus schauinslandi. U.S. Dep. Commer., NOAA, Southwest Region, 300 South Ferry St., Terminal Island, CA 90731, 44 p.

Interactions between weaned pups and adult patrolling males are probably dependent upon a number of complex factors, including visibility of pups to passing males, proximity of pups to other seals, age group of nearest neighbor, and previous experience of the pup, as well as state of the adult male. Based on the limited sample, sex of the weaned pup does not appear to be a factor.

Two of the most aggressive physical encounters seen at Laysan between weaned pups and other seals did not involve adult males, but involved a lactating female. When a weaned pup entered the small pool the mother was occupying with her 35-day-old pup, the mother vocalized, made mouth threats, and lunged violently at the weaned pup for 20 seconds, driving it over the reef edge within 1.5 m of aggregating gray reef sharks. The weaned pup responded by swimming rapidly back to its weaning site, over 100 m away, from which it had first ventured the day before. It remained at the weaning site the next 4 days. Although there was physical contact, no injuries were seen. Half an hour later there was a similar encounter when another weaned pup entered the pool. The female also drove this weaned pup within 1.5 m of the shark aggregation. This type of encounter appears to be much less frequent than those involving adult males.

As seen from the above, encounters between aggressive adults and weaned pups may be a factor in how quickly pups disperse from their weaning sites. These encounters are also a potential cause of serious injuries.

Sharks

One of the deaths and two of the injuries in 1982 were shark related. Although monk seal deaths caused by sharks have not been previously reported from Laysan, or from any of the atolls, it is not unexpected because of: 1) the number of sharks in the Northwestern Hawaiian Islands; 2) the observed number of seals with shark-inflicted scars or missing appendages, 3) seal remains have been found in shark stomachs (Taylor and Naftel 1978); and 4) a shark was seen feeding on a dead seal (Balazs and Whittow 1979). In addition to the seal injury with the missing hind flipper in 1982, at least four healed adult seals were seen with an entire appendage missing.

Occasionally large tiger sharks, 2.5 to 5 m total length, were seen patrolling the west side of Laysan during May and June, ranging from outside the reef edge to within a few meters of shore. Except for the seal death reported earlier, and the sharks near the Feressa, encounters between tiger sharks and monk seals were not observed.

As has been reported in the past (Johnson and Johnson 1978) gray reef shark aggregations were seen in the northwest area of Laysan. They were first observed in scattered numbers in mid-April, and increased until aggregations of over 60 individuals were seen in June. Numerous close encounters were observed between monk seals and the gray reef sharks, but except for their presence at the seal attack discussed earlier, no actual contact was seen. Patrolling adult male seals passed through the sharks without apparently altering speed or direction, and the sharks moved aside to keep a distance of at least 1 m between themselves and the seal; this is similar to

what has been reported in the past (Johnson and Johnson 1978). The aggregations frequently occurred in sector 2, in a channel adjacent to the main northwest pupping area. Weaned pups and mothers with pups were frequently nearby, and not always separated from the sharks by pools or reef edge, but the sharks appeared to be nonaggressive towards the seals.

Small numbers of what appeared to be gray reef sharks were also seen along the west, north, and northeast shores of Laysan, and a few individual whitetipped reef sharks, Triacnodon obesus, were seen on the west and northwest areas. Sharks were not seen inside the shallow waters of the east and southeast reef.

Entanglement Problem

Entanglements.--Three incidents of entanglement in debris were observed involving two weaned pups and a subadult; all three seals were seen entangled on land (Table 4 and Fig. 9). Only one incident involved net and rope. The seals were in apparent good health and the debris was removed by NMFS personnel. Numerous observations were made of seals placing their heads into or under debris with no resulting entanglement. Seals with obvious entanglement scars, such as deep neck marks, were not seen on Laysan, which indicates 1) that entanglement does not always result in obvious scars, 2) the result of serious entanglement is not always apparent on land, or (3) the rate of serious entanglement at Laysan is low.

Table 4.--Monk seal entanglement in debris, Laysan Island, 1982.

Date	Sex and age group	Debris	How entangled	Sector
6/13	Female, weaned pup	Plastic ring (115 mm diameter)	On muzzle	6
6/14	Female, weaned pup	Life preserver	Around neck	6
6/18	Female, subadult	Line, net	Around neck	7

Nonfatal entanglement in debris has been documented for the Hawaiian monk seal (Balazs 1979; Andre and Ittner 1980; Henderson¹¹). Entanglement has not been previously reported from Laysan. Deaths due to entanglement have been noted in other species (Fowler 1982) and in all likelihood also

¹¹J. R. Henderson, 1983. Encounters and entanglements of Hawaiian monk seal with lost and discarded fishing gear. Unpubl. manusc. Abstracts of the Fifth Biennial Conference on the Biology of Marine Mammals, November 27-December 1, 1983, Boston, Mass.

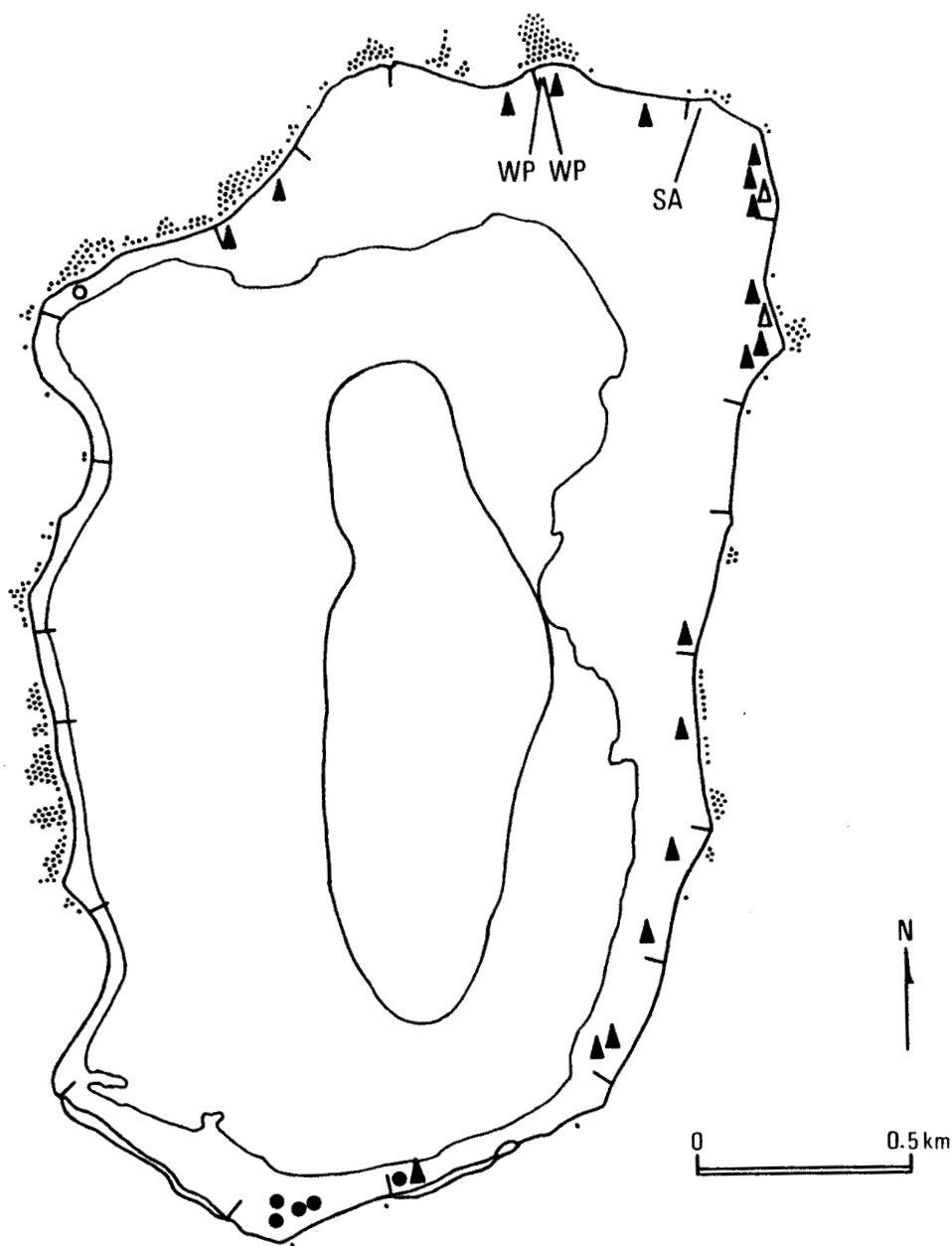


Figure 9.--Map showing location of weaned pups, net debris, and seal entanglement sites, Laysan Island, 1982. Small dots show the sector locations of weaned pups during censuses. Large circles and triangles show location of debris: ● = line/rope, ▲ = net or net with line present on 21 April inventory; ○ = line/rope, △ = net or net with line arriving between 22 April and 29 June. Entanglement sites for weaned pups = WP and subadults = SA.

occur among monk seals. The common practice of monk seals probing with the nose into debris and vegetation makes entanglement a potential problem on land and in water.

Weaned pups are extremely inquisitive and were involved in two of the three entanglements at Laysan. One pup was entangled in a life preserver and the other (Fig. 10) had a plastic ring on its muzzle. Thus, 2 out of 22 of weaned pups present during that time period were entangled in debris. Pup entanglement on nearby Lisianski Island during the same period was higher: 3 out of 23 weaned pups were trapped in the water in nets, plus there were several incidents of pups entangled in miscellaneous debris on land (footnote 3). Data are limited and the difference between islands may be an artifact because Lisianski is smaller and had more man-hours of observation. However, it is possible that entanglement of weaned pups at Laysan is lower because most of the pupping occurs where there is least debris (leeward side), and due to the size of the island, few newly weaned pups foray to the areas where much of the debris washed ashore (Fig. 9).

Net inventory.--Twenty-six large nets and rope were found (Fig. 9); 23 were present during the initial inventory on 21 April, and the other 3 washed ashore between 22 April and 29 June. Two of the latter were nets, and the third was a mooring line.

The 26 items inventoried consisted of the following: six lines or ropes, 0.5 to 7.5 cm diameter; three lines or ropes with net fragments, line diameter 3 mm to 10 cm; 17 nets, some with float and lead lines, mesh size (stretched diagonal) 6 to 90 cm, mesh line diameter 1 mm to 2 cm. The 13 nets which could be untangled for measurement totaled over 246 m². The largest individual net measured about 77 m². The net debris was in the water to 47 m inland. The pattern of other debris (bottles, plastics, etc.) on Laysan appears to follow that of the lines and nets; the debris is least abundant on the west (leeward) side, and most abundant on the northeast corner (windward side).

Analysis of Scats and Spews

Two hundred and ten scat, 40 parasitic scat, and 7 spew samples were collected. Identification of parasites and monk seal prey species is ongoing and will be reported elsewhere.

Endoparasites

Two of the parasitic scat samples are of special interest since they were collected from 1) a lactating female, and 2) a pregnant female who pupped within 24 h of the scat collection. Both females were large and appeared healthy.

The lactating female had nursed her pup 35 days, and continued to do so for an additional 4 or 5 days. The amount of scat was negligible, most soaked into the sand, but nematodes and cestodes were collected. Her pup at weaning appeared large and healthy.

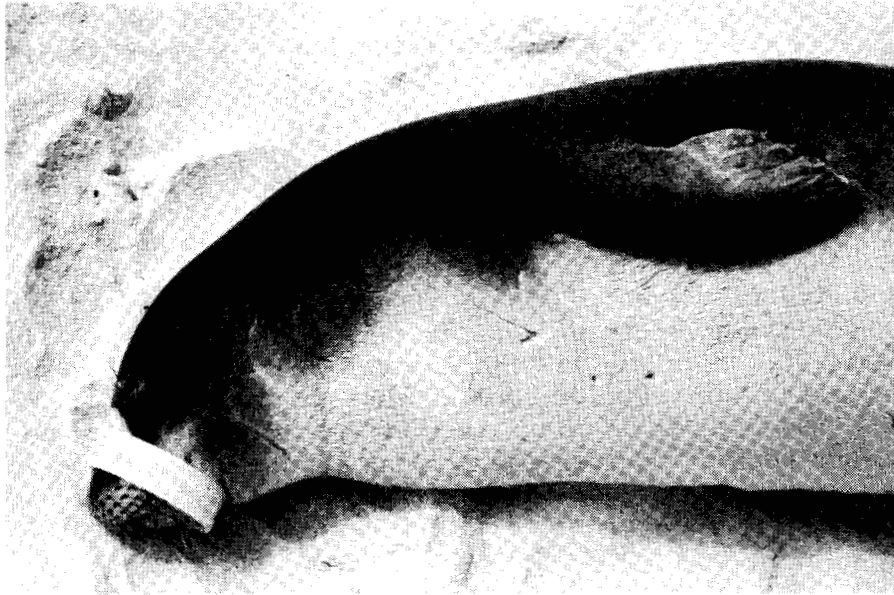


Figure 10.--Weaned pup with plastic ring stuck on muzzle.



Figure 11.--Filefish with dorsal spine embedded in weaned pup's mouth.

The scat from the pregnant female contained cestodes (tapeworms and proglottids). She was still nursing her pup when the field camp departed; the pup appeared healthy and large after 30 days of nursing.

Miscellaneous Observations

Shivering

A 7-day-old shivering pup was observed on the afternoon of 10 April 1982. The pup was still shivering when observations were terminated after 5 min. The pup was on the windward side of its mother and close to her posterior, but there was no body contact. The pup's pelage was wet due to rain. Air temperature was 20°C, the sky was overcast, and wind speed was estimated at 40 km/h and constant. The pup appeared to be healthy and was large when weaned at 41-43 days of age.

Fish Attached to Seal Mouth

A juvenile male seal was seen with a filefish, approximately 15 cm total length, stuck at the right corner of its mouth (Fig. 11). The spine of the fish was completely embedded in the seal. The seal appeared healthy and there was no sign of edema, festering, or discomfort.

ACKNOWLEDGMENTS

I would like to thank the captains and crews of the NOAA vessel, Townsend Cromwell, which provided transportation to and from Honolulu, the Feresia which brought supplies and mail, the Easy Rider which provided transportation to Lisianski when the Laysan field camp was disbanded, and the Wicked Wahine which provided a home cooked meal. Thanks are extended to the U.S. Fish and Wildlife Service which administers the Hawaiian Islands National Wildlife Refuge, especially to John Andre and other personnel on Tern Island who relayed our radio messages to Honolulu. Thanks also are extended to the U.S. Coast Guard for the airdrop of mail and supplies.

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Appendix A.--Itinerary for the 1982 Laysan Island field work.

Date	Location
3/12	Fly from Honolulu to Tern Island, French Frigate Shoals.
3/13	Depart Tern Island aboard the <u>Townsend Cromwell</u> .
3/15	Arrive at Laysan Island. <u>Townsend Cromwell</u> departs same date after establishing two-person field camp consisting of D. Alcorn and A. Kam.
6/30	Laysan field camp disbanded. D. Alcorn and A. Kam depart Laysan Island for Lisianski Island aboard the <u>Easy Rider</u> .
7/1	Arrive at Lisianski Island to join field camp.
7/10	<u>Easy Rider</u> en route from Lisianski Island to Honolulu stops at Laysan Island. W. Gilmartin and J. Henderson conduct census and depart same date.
9/16	Lisianski field camp disbanded. Depart Lisianski Island aboard <u>Townsend Cromwell</u> .
9/20	Arrive Honolulu.

Appendix B.--Summary of Laysan Island censuses, 1982 (M = male, F = female, ? = sex unknown, W = weaned, N = nursing).

Date	Adult			Subadult			Juvenile			Pups		Observer ¹	Total		
	M	F	?	M	F	?	M	F	?	W	N		In molt	Non-pups	Pups
3/17 ²	--	--	--	--	--	--	--	--	--	0	5	AK, DA	0	92	5
3/18	16	10	30	5	2	16	2	5	12	1	6	DA	0	98	7
3/21	19	15	20	6	3	5	5	8	11	1	8	AK, DA	0	92	9
3/23	13	12	26	4	0	15	8	4	15	1	9	DA	0	97	10
3/26	17	23	26	7	5	12	4	7	8	1	8	AK, DA	0	109	9
3/28	32	18	19	3	13	10	6	4	8	1	8	DA	0	113	9
3/30	30	16	22	3	10	7	3	4	3	1	7	AK, DA	0	98	8
4/1	22	16	16	4	6	6	7	5	8	1	9	DA	1	90	10
4/3	25	15	22	4	5	11	2	3	2	2	9	AK, DA	1	89	11
4/5	30	21	18	11	6	10	9	3	11	2	9	DA	1	119	11
4/8	34	21	15	8	5	12	3	2	4	3	9	AK, DA	3	104	12
4/10	17	17	26	1	5	5	2	3	8	3	9	DA	4	84	12
4/12	43	20	15	9	5	11	3	1	3	3	0	AK, DA	4	110	13
4/15	23	25	9	8	7	10	5	2	5	3	1	DA	3	94	14
4/17	32	27	14	8	1	6	2	1	4	3	1	AK, DA	3	95	14
4/19	28	21	11	1	3	14	6	2	13	2	1	DA	5	99	13
4/23	20	18	17	4	11	3	6	1	4	3	1	DA	5	84	14
4/25	20	15	15	4	5	6	0	0	1	8	7	AK, DA	5	66	15
4/27	28	24	11	4	7	2	3	1	4	7	9	DA	5	84	16
4/29	26	19	24	7	9	6	4	0	6	8	9	AK, DA	8	101	17
5/1	25	21	7	2	8	5	5	2	4	7	9	DA	6	79	16
5/3	33	13	13	7	11	2	2	2	3	8	8	AK, DA	5	86	16
5/5	31	26	11	4	6	2	7	2	5	6	9	DA	5	94	15
5/7	32	27	11	4	8	4	5	0	4	7	11	AK, DA	4	95	18
5/9	20	26	2	3	8	5	5	1	6	5	11	DA	3	76	16
5/11	30	25	8	1	4	13	5	0	0	6	11	AK, DA	3	86	17
5/13	14	28	3	3	7	4	4	3	4	7	11	DA	3	70	18
5/15	23	22	12	2	7	10	5	0	1	7	11	AK, DA	0	82	18
5/17	28	23	10	1	2	6	3	4	7	8	12	DA	4	84	20
5/19	19	16	11	5	0	12	7	3	2	11	7	AK, DA	4	75	18
5/21	21	23	8	3	5	6	5	3	4	13	9	DA	4	78	22
5/23	31	19	9	5	3	6	6	2	6	11	9	AK, DA	5	87	20
5/25	20	17	12	4	9	6	7	5	1	10	8	DA	3	81	18
5/27	26	20	13	7	8	7	2	1	2	14	8	AK, DA	2	86	22
5/29	26	25	4	6	8	0	3	2	4	7	10	DA	5	78	17

Appendix B.--Continued.

Date	Adult			Subadult			Juvenile			Pups		Observer ¹	Total		
	M	F	?	M	F	?	M	F	?	W	N		In molt	Non-pups	Pups
6/1	37	23	10	2	5	7	9	1	4	14	9	AK, DA	4	98	23
6/3	27	21	13	4	9	6	4	4	5	13	8	DA	11	93	21
6/6	29	23	12	6	5	11	4	7	4	12	9	AK, DA	8	101	21
6/8	25	25	19	4	8	10	2	3	2	16	10	DA	10	98	26
6/12	18	18	20	3	8	5	5	1	6	13	8	DA	11	84	21
6/14	35	17	11	7	13	6	0	1	3	17	7	AK, DA	8	93	24
6/16	24	19	19	4	6	9	4	4	11	16	7	DA	12	100	23
6/18	23	23	24	8	5	7	5	2	2	16	7	AK, DA	10	99	23
6/21	15	20	21	7	5	7	6	4	4	15	8	DA	10	89	23
6/23	16	20	14	4	9	7	1	2	6	16	7	DA	6	79	23
6/26	11	14	29	4	4	11	3	1	5	18	5	DA	8	82	23
6/29 ³	21	13	19	3	6	9	2	2	7	14	4	WG, DA	11	82	18
7/10	9	20	10	4	2	8	4	6	5	10	3	JH, WG	6	68	13

¹AK = Alan K. H. Kam, DA = Doris J. Alcorn, WG = William G. Gilmartin, JH = John R. Henderson.

²This was a preliminary census conducted to familiarize observers with Laysan.

³Considered to be a "one-person" census because both persons circuited the entire island together.

Appendix C.--Summary of Laysan pups, 1982 (20 females, 9 males, 1 unknown).

No. ¹	Sex	Birth		Weaning date	Lactation period ²	ID of mother ³
		Date	Sector			
1	F	⁴ --	⁵ (Northeast)	Before 3/20	--	--
2	M	--	(East)	Disappeared	--	--
3	F	--	(Northwest)	4/2	--	07F
4	F	--	(Northwest)	4/6	--	08F
				5/18-19	34-35	⁶ 18F
5	M	--	(Northwest)	4/10-11	--	09F
6	F	March	(Northwest)	4/23-25	--	10F
7	M	March	20	4/24-25	--	11F
8	F	3/17-18	2	4/24-25	37-39	03F
9	M	3/18-21	20	4/23-25	33-38	12F
10	F	3/20-21	5	4/22-23	32-34	04F
11	M	3/30	3	5/17-18	48-49	13F
12	F	4/2-3	10	5/15	41-43	14F
13	F	4/5-6	2	5/15-17	39-42	15F
14	F	4/8-9	20	5/18-19	39-41	16F
15	M	4/11-12	2	Died	--	18F
16	F	4/14-15	20	5/24-25	39-41	17F
17	F	4/20	11	5/31	41	19F
18	F	4/23-24	2	6/1-2	38-40	20F
19	M	4/28-29	19	6/10-11	42-44	21F
20	F	5/5	18	6/12-14	38-40	22F
21	F	5/5-7	13	6/12-14	36-40	23F
22	M	5/12-13	19	6/26	43-44	24F
23	F	5/15-16	2	6/21-22	36-38	25F
24	F	5/20-21	2	6/22-23	32-34	26F
25	F	5/25-27	4	--	--	33F
26	F	5/29	20	--	--	32F
27	F	6/5	20	--	--	34F
28	F	6/7	20	--	--	35F
29	M	6/18	19	--	--	39F
30	--	--	(East)	--	--	--

¹Probable order by birth.

²Lactation period shown includes day of birth but does not include day of weaning.

³Identification number in Laysan monk seal identification file, Honolulu Laboratory Southwest Fisheries Center, National Marine Fisheries Service, NOAA, Honolulu, Hawaii.

⁴Undetermined.

⁵Area of Laysan where first seen.

⁶Foster mother.

Appendix D.--Monk seal necropsy reports, Laysan Island, 1982 (Pathologist was G. Stemmerman, Kuakini Medical Center, Honolulu.)

Field No.: 01NEC, 15 pup

Date/time of death: Between 11 April at 1050
and 12 April at 1212

Date/time of necropsy: 13 April at 1500

Sex: Male

Age: Pup, new born

- I. Circumstances of death: Pup was never seen alive. Portion of lung floated indicating pup had drawn breath, but pathologist's report found evidence of incomplete pulmonary aeration and aspirated amniotic fluid, indicating respiratory distress during birth. This was probably of traumatic origin, indicated by hemorrhage and possible laceration of the liver.
- II. External description: No external marks or wounds. Fly larvae on pelage. Well developed nails, foreflipper = 2 cm, hind flipper = 12 mm. Fecal matter on hind flipper. Teeth not erupted.

Measurements:

1. Standard length (nose tip to tail tip, dorsal side up)... 107 cm
2. Curvilinear length..... 111 cm
3. Anterior length foreflipper..... 20 cm
4. Anterior length hind flipper..... 21 cm
5. Axillary girth..... 48.5 cm
6. Blubber thickness (at sternum)..... 5 mm
7. Other, length of umbilicus..... 14 cm

- III. Internal: Trachea contained yellow froth. Stomach empty. Intestines contained yellow-brown fluid along entire length. Spleen size 6 x 18 cm. No endoparasites. Skull intact.

IV. Samples collected:

Heart	Pancreas	Spleen	Testes
Lung	Stomach	Kidney	Placenta
Liver	Intestine	Adrenals	Skeletal: skull, baculum

Appendix D.--Continued.

Field No.: 02NEC
 Date/Time of Death: Between 13 May at 1985
 and 14 May at 1800
 Date/time of necropsy: 14 May at 1830
 Sex: Female
 Age: Juvenile

- I. Circumstances of death: First seen hauled out 9 May at 1530, alert, edema and draining wound on left dorsolateral, open wound posterodorsal, no bleeding. Seen again 10 May. Tentatively identified on 13 May, hauled out then entered water. Floating dead 14 May. Extensive body edema, parasites and associated ulceration of the stomach, and heavy load of intestinal parasites. Pathologist found necrosis of the liver and bacteria in the liver and blood vessels of other organs.
- II. External description: Body rigid. No pelage slippage or fly larvae. Small dorsal scratches 1 to 5 cm long, probably from floating over exposed reef after death. Identification characteristics: natural bleach mark on back of neck, 4-5 cm diameter, green around mouth and lateral body. Four areas of injury:
1. Posterodorsal open wound, 8 x 5 cm, 1.5 cm deep, no edema.
 2. Dorsolateral wound, 8.5 x 3.5 cm, blubber exposed, no edema.
 3. Left dorsolateral wound, broken skin 3 x 2.5 cm, edema 9 cm diameter; when incision made, yellow-red fluid extended to muscle layer.
 4. Right dorsolateral wound, broken skin 4.2 x 3.5 cm; massive edema 33.5 cm diameter; when incised, red-brown fluid extended into muscle area.

Measurements:

1. Standard length (dorsal side up)..... 138.5 cm
2. Curvilinear length..... 150.2 cm
3. Anterior length foreflipper..... 27.0 cm
4. Anterior length hind flipper..... 28.8 cm
5. Axillary girth (taken across area of edema)..... 93.6 cm
6. Blubber thickness (at sternum)..... 2.5 cm
7. Blubber thickness (anterior nipples)..... 2.8 cm

- III. Internal: Trachea contained yellow froth. Stomach empty, with nine gray ulcerated areas, the largest 2.5 cm long, some with attached nematodes. Intestines contained yellow-brown fluid and helminths along entire length; masses of parasites were so heavy in some areas they almost occluded the intestine. Spleen size 8 x 28 cm. Ovaries 2.2 x 1.2 cm.

IV. Samples collected:

Heart	Pancreas	Spleen	Ovaries (entire reproductive)
Lung	Stomach	Kidney	Muscle (midlateral)
Liver	Intestine	Adrenals	Skeletal: Skull
			Endoparasites

Appendix D.--Continued.

Field No.: 03NEC
Date/time of death: Estimated 4-7 days
 before necropsy
Date/time of necropsy: 21 June at 1900
 Sex: Female
 Age: Adult

- I. Circumstances of death: Unknown. Lacked wounds or abnormalities. Seen on 19 April, otherwise not identified until was found floating dead on 21 June.
- II. External description: Molted, hair slipping. No visible wounds; some small skin breaks, probably from abrasion on reef after death. Identification marks: white mark on foreflipper and hind flipper.

Measurements:

1. Standard length (ventral side up)..... 212.0 cm
2. Curvilinear length..... 216.0 cm
3. Anterior length foreflipper..... 33.5 cm
4. Anterior length hind flipper..... 34.5 cm
5. Axillary girth..... 113.0 cm
6. Blubber thickness (at sternum)..... 2.5 cm
7. Blubber thickness (anterior nipples)..... 2.5 cm

- III. Internal: Organs discolored. Esophagus contained nematodes. Spleen 10 x 27 cm. Stomach had ulcers covering about 10% surface area, the largest 7 cm long; some nematodes but none attached. Intestines contained small amount of fluid and light load of helminths entire length; size of cestodes appeared constant throughout tract. Skull intact.
- IV. Samples collected: Samples were taken but due to deterioration of the carcass were not saved except for the following:

Reproductive tract (entire)

Skull

Endoparasites

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